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PALEONTOLOGY.—*New Carboniferous invertebrates—I.*[1] GEORGE H. GIRTY, U. S. Geological Survey.

This paper contains descriptions of two brachiopods, two pelecypods and one gastropod from Arkansas, and one brachiopod from Kansas.

Streptorhynchus affine. n. sp.

Figures 5–11

Shell small, a width of 25 millimeters being the maximum.

The brachial valve is subquadrate, strongly transverse, somewhat contracted at the hinge, straight or emarginate along the anterior border. The convexity is low with, for the genus, a remarkably strong sinus which is narrow posteriorly but widens rapidly toward the front.

The pedicle valve is subconical and rather strongly elevated. It is gently curved from side to side and nearly straight from apex to points in the margin, but as the growth is more or less distorted, these statements are only of general application. The angle made by the cardinal area with the plane of the shell margins varies considerably; usually it is obtuse but it may be a right angle. The height of the area is of course largely determined by the height of the valve and in most specimens it is rather high. The area is often planate but as the beak is apt to be bent to one side or the other, or even backward (rarely forward), so the area is sometimes more or less curved. It is sharply defined on each side by an angular shoulder which in many specimens is emphasized by a depression or groove down the convex or anterior part of the shell.

The surface is marked by rather stout rounded radii which diverge rapidly so that the interspaces make room for frequent intercalations. The radii are rounded and closely arranged; they are generally rather thick but thicker in some specimens than in others. At points of intercalation they are separated by intervals of about their own width; elsewhere they are wider than the intervals. They appear in most specimens to be subequal, but in some the arrangement is more conspicuously alternating and in a few every fourth or fifth one is much stronger than those between. The radii are crossed by sublamellose concentric, crowded, incremental lirae, and varices of growth

[1] Published by permission of the Director of the U. S. Geological Survey. Received March 1, 1929.

are rather numerous though not very strong. In some specimens the concentric markings are sharply developed; in others they are obscure though this effect can sometimes be ascribed to abrasion.

The interior of the pedicle valve is devoid of septal plates and the dental plates are reduced to thick but low ridges. The apex of some pedicle valves is more or less filled in by a callosity. The brachial valve has a short, broad, bilobate, cardinal process and rather short, though stout socket plates which are bent so that for much of their length they are parallel to the hinge line.

Horizon and locality: Stanton limestone; cut on the Frisco railroad, 1¼ miles southeast of Fredonia, Kansas.

Streptorhynchus suspectum, n. sp.

Figures 12–15

Shell rather large, ovate. A large pedicle valve measures 45 millimeters in width, but most are smaller; some associated brachial valves on the other hand are even larger.

The pedicle valve is high and conical. The outline rounds inward rather strongly at the cardinal angles and the hinge is considerably shorter than the width in front. The growth is very irregular and no two specimens have the same shape. In some the apex is twisted to one side or the other or bent backward over the area (never in the opposite direction) and most have abrupt expansions and contractions, or flare in bell fashion at the margin. The area is high but variable. It makes an obtuse angle with the plane of the valves, though in some shells the angle is much wider than in others. The area is generally flat but may be arched, especially in the upper part. It joins the lateral slopes in sharp angles. The pseudo-deltidium is gently convex and very elongate, the height being several times the width of the base, the ratio varying, however, with the height of the valve.

The brachial valve varies in configuration though it varies much less than the other. In describing this valve I can but note the characters of the dorsal shells that occur at the same locality as the ventrals, for in only one instance have the two valves been found in conjunction. Many of the brachial valves are highly convex, rising to a very prominent umbonal region with a steep descent to the depressed beak which sometimes is almost bent in under the parts above. On the other hand, some specimens, mostly small ones, are rather flat and may even be concave in the umbonal region. Many are also marked with constrictions or undulations due to irregular growth.

The surface is crossed by extremely fine sharp radial lirae. On some specimens the interspaces are wider than the lirae; on others, because of more frequent intercalation, they are of about the same size and on many the lirae multiply rapidly over the marginal parts where they are especially fine and crowded.

The internal structures are not well shown by my specimens and my observations are somewhat contradictory. Where any evidence could be gathered at all it seemed in most instances to show that a median septum was absent in the pedicle valve; dental plates, in any strict sense, are also absent, though the edges of the delthyrium are thickened so as to form distinct dental pillars. On the other hand, in one specimen especially, the median line appeared to be signalized by a low thin ridge which though inconsiderable in height, was yet suggestive of a septum. Less pronounced manifestations of a like development were observed on other specimens, but externally all of the specimens present the same appearance and offer no grounds for discrimi-

nation. A rather common peculiarity, though a feature more perhaps of configuration than of structure, is that many specimens are flattened in the rostral region as if compressed and bear a rather deep, rather narrow indentation; this is received by the internal mold which in turn appears as if the shell there had been thickened into an elongated solid platform of irregular shape.

The associated brachial valves have a low blunt median ridge or septum and long and somewhat curved socket plates.

This species is rather clearly distinct from *S. ruginosum* by reason of its more elevated pedicle valve with its correspondingly narrower delthyrium, and it also has finer and more crowded radiating lirae. Some uncommonly low pedicle valves of this species may not differ appreciably from some uncommonly high pedicle valves of that; so also may the surface striae of that species be in some rare specimens almost as fine and crowded as the surface striae of this, but the generality of specimens differs markedly. In configuration *S. suspectum* is more like the species for which Hall and Clarke introduced the name *S. ulrichi*. They did not, however, describe *S. ulrichi* and by way of illustrating it gave but a single figure representing the interior of a pedicle valve. It was later described and figured by Weller and the data thus made available show that the surface striae of *S. ulrichi* are uncommonly coarse, in marked contrast to the surface striae of *S. suspectum* which are uncommonly fine.

Horizon and locality: Pitkin limestone; Fayetteville quadrangle, ½ mi. north of West Fork, Ark.; Eureka Springs quadrangle, eastern border of sec. 21, T 16 N, R 27 W., Ark.

Tetracamera neogenes, n. sp.

Figures 1–4

Shell rather large, subovate. Width greater than the length, the width in the largest specimens seen being 30 millimeters.

Pedicle valve ovate to pentagonal in shape, widest at about the mid-length. The convexity is high longitudinally but transversely rather low. The sinus is broad, subtending an angle considerably more than one-fourth but rather less than one-half that of the whole valve. The posterior end of the valve is nearly planate, but shortly the median part begins to be depressed, the depression becoming somewhat rapidly deeper and broader, producing thus a broad, flat sinus; the sides meanwhile remain nearly flat or are bent down slightly, near the margin. The shell is rather sharply folded downward at the sides of the rostral portion in almost planate areas which slope outward more or less making with the main part of the valve a distinct angle of more than 90°. In gibbous specimens the anterior part of the sinus is somewhat abruptly bent downward to a direction almost perpendicular to the plane of the lateral margins. The plications are broad, subangular, and moderately strong. They become deep and angular toward the antero-lateral margins, but in the posterior third of the shell they are rather obscure. Normally three occur in the sinus and four on each of the lateral slopes, the final one being the angle that defines the inflected areas on either side of the beak.

The brachial valve is highly convex, not much curved in an antero-lateral direction but strongly arcuate from side to side. In gibbous specimens the shell at the anterior margin is abruptly and strongly deflected to a direction almost perpendicular to the part that preceeded it. The fold is broad and

flat, occupying about one-third of the valve, the lateral thirds falling away strongly at the sides. The plications are broad, low and more or less rounded. Near the front of the fold they become strong and angular but in the rostral region they are more or less indistinct. Normally four occur on the fold and three on each side. The fold and sinus are not well defined superficially except near the margin, but the deflection which they produce in the line of junction of the valves is abrupt and strong.

The internal structures have not been ascertained in detail, but in essentials they agree with the genus established by Weller. The pedicle valve is provided with two powerful dental plates which are connected with the sides of the valve in the rostral region by buttress plates, one on each side. The dental plates converge toward the median line but meet the bottom of the valve before they meet each other. Consequently they are not supported on a septum to form a spondylium, unless, as the test is very thick such a structure is present but buried within the shelly mass; this is highly improbable. A slight ridge or septum passes down the median line, however, rising from the bottom of the valve between the dental plates. The brachial valve has a well developed median septum which apparently unites with the hinge plate much as in *Camarotoechia*.

Somewhat paradoxically, *T. neogenes* is in its specific characters much more nearly allied to *T. subtrigona*, the oldest of the *Tetracameras*, than to the species which are nearest in geologic age, though *T. neogenes* is considerably younger than any of them. It is smaller than *T. subtrigona* and has fewer plications differently distributed.

Horizon and locality. Pitkin limestone; Yellville quadrangle, near St. Joe, Arkansas.

Nucula elegantula, n. sp.

Figures 19–21

Shell large, strongly transverse, irregularly ovate to subtriangular in outline. The type specimen is 11 millimeters wide, 8 millimeters high and 6 millimeters thick. The convexity is moderately strong. The upper surface of the valves is gently arched but the dorsal margin is abruptly and strongly inflected both before and behind the beak. Shortly, however, these margins bend outward again, so that grooves are formed that rather sharply define a lunule and an escutcheon. These grooves also sharpen the angle made by the inflected margins with the upper surface. The lines thus formed in the side view, meet at the umbo in an angle slightly less than 90° though the outline of the shell, because the lunule and escutcheon project slightly, is a little greater than 90°. Owing to the conformation just described the beaks are very prominent. They are fairly large and strongly incurved; although owing to the obliquity of the axis of the shell the beaks are directed backward, they do not curve in either direction. The outline of the shell as a whole is comparable to a triangle, in which the ventral side is the longest, the anterior side shorter than the ventral side and the posterior side much shorter than either. The ventral outline is rather regularly and strongly convex. The lines defining the umbo are slightly concave; that on the posterior side meets the ventral margin almost in an angle, the anterior end being less abruptly rounded. The anterior and posterior outlines have a duplex character owing to the lunule and escutcheon which are partly visible in the side view and partly obscured.

The surface is marked by fine, regular, concentric striae.

N. elegantula is more similar to *N. illinoisensis* than to any Mississippian species. Its distinguishing characters are its larger size, more transverse shape, and more distinct lunule and escutcheon.

Horizon and locality: Fayetteville shale; Winslow quadrangle, 2 miles north of Cold Spring, Ark.

Deltopecten bellistriatus, n. sp.

Figures 22, 23

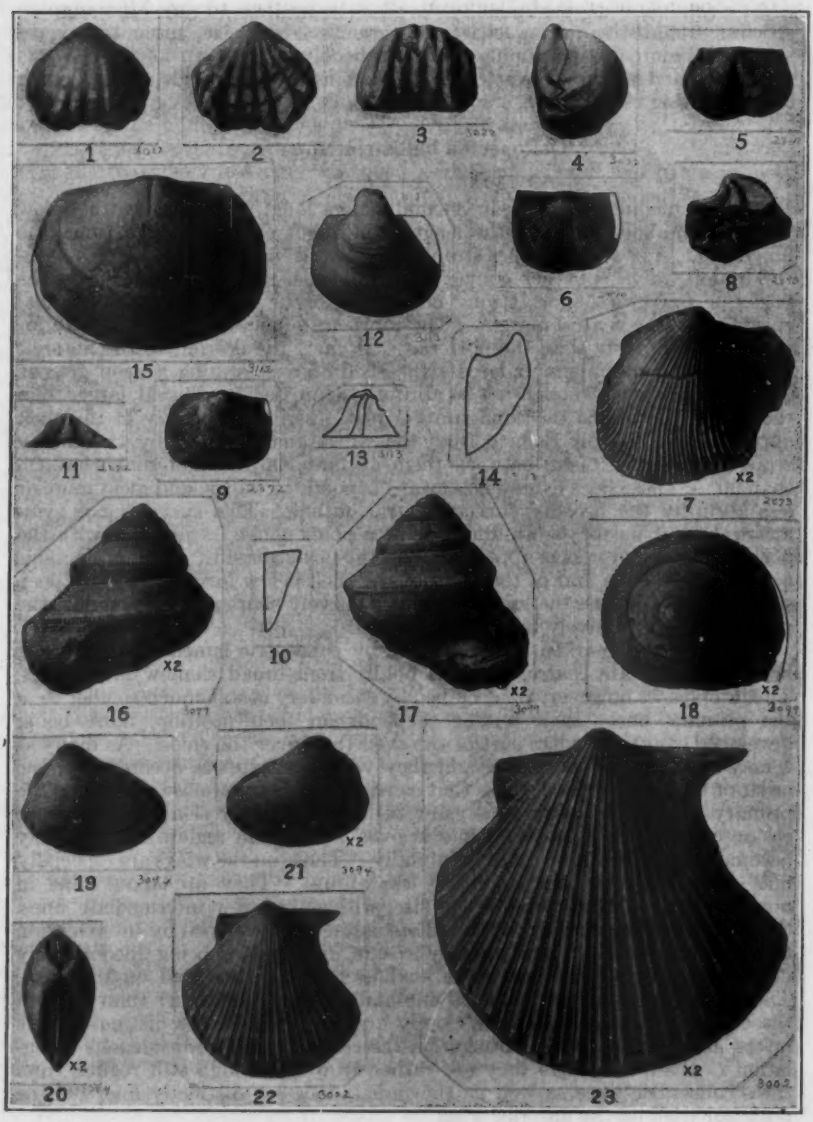
Shell of medium size, rarely 30 millimeters long. Greatest width below the middle, about equal to the length and about one and a half times the hinge line. Axis with a rather strong backward trend.

The left valve is rather convex for the genus, somewhat gibbous in the posterior part with short strong curvature to the beak and long gradual curvature to the ventral margin. The wings are much depressed, the anterior wing more abruptly than the posterior. In fact, the descent to the anterior wing in some specimens undercuts the shell above, forming a deep groove. The posterior wing, though not so abruptly depressed, is as usual, larger than the other. Owing to the configuration just described the body of the shell appears to be sharply defined from the wings and bounded by two nearly straight lines that make between them an umbonal angle of somewhat less than 90°. These lines extend downward beyond the wings, and meet more or less abruptly the broadly curved ventral outline. This curve is not symmetrical for it meets the anterior line at a point above its junction with the posterior line, and it sags appreciably on the posterior side. The projections of the wings above and of the body of the shell below form two broad, deep sinuses in the outline the anterior sinus relatively short and subangular, the posterior sinus relatively broad and rounded.

The surface is marked by costae and by concentric lamellose lines. The primary costae are coarse, and rise boldly from broad shallow interspaces. The interspaces however, are occupied by secondary costae much smaller than the primary ones; their number depends on their position, more being developed over the median part of the shell than over the sides. As many as 4 may occur in one interspace and they vary much in size according to the order of their appearance, those that came in first being almost as large as the primary costae, but those that came in last being very slender. Thus the costae conspicuously alternate in size over the median region but gradually become smaller and more uniform laterally. Those on the wings are especially fine, the transition being more or less abrupt. They are about nine in number and are nearly uniform in size, with only a few intermediate ones. On the body of the shell the intermediate costae are developed by intercalation though some of the large primary costae are double, being incompletely divided into two small ones by a shallow groove introduced on the crest. The concentric lamellose lines are fine and regular, much finer than most of the costae and somewhat more closely arranged. They are distinct on the interspaces and somewhat stronger on the costae, making conspicuous crenulations. Over the wings they are rather crowded though still regular, and these concentric lines as well as the radial ones are distinctly finer on the posterior than on the anterior wing.

The right valve is unknown.

This species is of the general type of *D. monroensis* but it is a larger shell, has a more elongate shape and much coarser sculpture with more conspicuously alternating costae. It resembles *D. batesvillensis* but differs consider-



Figures 1–23.—1–4, *Tetracamera neogenes* Girty, n. sp.; 5–11, *Streptorhynchus affine* Girty, n. sp.; 12–15, *S. suspectum* Girty, n. sp.; 16–18, *Worthenia tenuilineata* Girty, n. sp.; 19–21, *Nucula elegantula* Girty, n. sp.; 22–23, *Deltopecten bellistriatus* Girty, n. sp.

ably in the character of the sculpture which is coarser, the costae being not only larger but more widely spaced and hence less numerous.

Horizon and locality: Fayetteville shale; Marshall quadrangle, ½ mile southeast of Marshall, Ark.

Worthenia tenuilineata, n. sp.

Figures 16–18

Shell rather large, consisting of 7 volutions. Spire somewhat low (about ⅔ of the height) and somewhat turreted. Final volution strongly carinate; the carina, which forms the peripheral line and carries the slit band, is situated at about the mid-height. The surface above the carina slopes with strong obliquity from the suture. It is rather broad and is slightly sinuate in outline, a trifle swollen at the suture and gently concave toward the carina. The surface below the carina is directed obliquely downward and inward for a space about equal to the upper surface, then, upward and inward. The surface below the carina is much more highly arched than that above, concave at first for a short distance, then gently convex around to the impressed zone, without any abrupt change of direction. This configuration is confined to the last two volutions more or less, the earlier whorls, 4 or 5 in number, being more regularly rounded. The volutions embrace rather more than half the infra-carinal surface, so that the lower part of the shell is strongly turreted, but the upper part much less so. This difference is due to the rounded shape of the early volutions together with the rapid increase, absolutely if not relatively, in the surface left exposed below the carina by the overlapping whorls.

The surface both above and below the carina is finely cancellated by revolving and transverse lirae, though the upper surface is somewhat more coarsely marked than the lower. The revolving lirae of the upper surface, 13 or 14 in number, are not entirely equal in size or regular in arrangement, but on the

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DESCRIPTION OF FIGURES

Tetracamera neogenes, n. sp. (p. 140).

Figs. 1–4. One of the cotypes. Pitkin limestone near St. Joe, Arkansas.

Streptorhynchus affine, n. sp. (p. 140).

Figs. 5–11. Several of the cotypes. Figure 5 represents an uncommonly indented and figure 6 an uncommonly flat brachial valve. Figures 7 and 8 represent a contorted pedicle valve and figures 9–11 represent a more symmetrical one. Stanton limestone near Fredonia, Kansas.

Streptorhynchus suspectum, n. sp. (p. 140).

Figs. 12–15. Two of the cotypes, one of them being a small pedicle valve, the other a much exfoliated brachial valve. Pitkin limestone in the Fayetteville quadrangle (figures 12–14) and in the Eureka Springs quadrangle (figure 15), Arkansas.

Worthenia tenuilineata, n. sp. (p. 140).

Figs. 16–18. The type specimen, × 2. Fayetteville shale, Eureka Springs quadrangle, Arkansas.

Nucula elegantula, n. sp. (p. 140).

Figs. 19–21. The type specimen, × 2. Fayetteville shale, near Cold Spring, Arkansas.

Deltopecten bellistriatus, n. sp. (p. 140).

Figs. 22–23. Two views, one enlarged 2 diameters, of the type specimen, a left valve. Fayetteville shale, near Marshall, Arkansas.

whole they are rather narrower than the interspaces. The transverse markings are more of the nature of lamellae than the revolving ones and are more closely arranged. They trend slightly backward from the suture and take on a more distinct retral curve as they near the carina. The points of intersection with the revolving lirae are marked by fine nodes. For a certain distance below the carina the revolving lirae are rather crowded because of small secondary lirae developed in the interspaces but toward the umbilicus they become somewhat larger and more uniform in size as well as more loosely arranged. The transverse lines are distinctly finer, fainter, and more closely spaced than those above the carina. Their course is doubly sinuate. Swinging strongly forward from the carina they shortly change direction so as to make a broad low arch; this is followed by a broad shallow sinus which in turn is replaced near the axis, by a backward curve.

The carina is formed by the slit band which is inclosed between two sharp edges or lamellae that distinctly define it. The band itself, however, is prominent, projecting beyond the bounding lamellae. It is conspicuously marked by strong, regular lunettes and also by revolving lirae, two in number, that are interrupted by the lunettes and appear only as two rows of small nodes connected by more or less obscure raised lines.

W. tenuilineata appears to be more nearly related to the common Pennsylvanian *W. tabulata* than to any Mississippian species that have been referred under *Worthenia*. In *W. tabulata*, however, the spire is more strongly turreted, the lateral surface is sharply defined by an angle from the lower, and the sculpture, especially that on the lower part of the volutions, is much coarser.

Horizon and locality: Fayetteville shale; Eureka Springs quadrangle, S. E. ¼ sec. 15, T 16 N, R 27W., Ark.

PALEONTOLOGY.—*Two new species of "Orthophragmina" from Calita Sal, Peru.*[1] WILLARD BERRY Johns Hopkins University. (Communicated by JOHN B. REESIDE, JR.)

In 1928 I assigned a new species of *"Orthophragmina"* to a new subgenus *Asterodiscocylina*.[2] Since that time other material from the same locality has yielded two more new species of *"Orthophragmina,"* which are described in this paper. Many specimens of *Asterodiscocylina stewarti* W. Berry were also included; several specimens of *Liothyina peruviana* of Olsson, who says that it is found in the Saman Conglomerate near Organo Grande and Quebrada Canoas, Department of Piura, Peru; and *"Orthophragmina" peruviana* Cushman, which is found in the Eocene at the horizon of the Saman Conglomerate. Tobler lists *"Orthophragmina" asteriscus* Guppy from a locality just south of Calita Sal at Punta Sal.[3] I have examined my material

[1] Received March 1, 1929.

[2] WILLARD BERRY. *Asterodiscocylina, a new subgenus of Orthophragmina.* Eclogae geol. Helvetiae **21** (2). 1928.

[3] A. TOBLER. *Neue Funde von obereocänen Grossforaminiferen in der nordperuischen Küstenregion.* Eclogae geol. Helvetiae **20**. 1927.

with a great deal of care and have failed to find any four-rayed species, but have found some small portions of six-rayed forms broken so as to resemble a badly preserved, possibly four-rayed form. On the basis of the associated fossils the beds containing the material here described are correlated with the Saman Conglomerate as described by Olsson and Iddings,[4] and by Olsson.[5]

The two species may be described as follows:

"Orthophragmina" (Discocylina) salensis, W. Berry, n. sp.

Figs. 1, 2

Test large, very thin, umbonate; diameter 5 to 9 mm., thickness 0.7 mm., ratio of diameter to thickness 13- to 1; small central boss 1 mm. in diameter, flange about 4 mm. in diameter. Surface covered with small papillae about 78 microns in diameter at the surface. Surface diameter of the lateral chambers 27.3 microns.

In equatorial section the nucleoconch composed of two chambers, the initial chamber 136.5 microns in diameter and half surrounded by the second chamber; diameter of the entire nucleoconch 292.5 microns, the walls of the nucleoconch very thin, being only about 7.8 microns thick. At about 1 mm. from the center the equatorial chambers of typical rectangular "Orthophragmina" shape, 35.1 microns in radial diameter, 19.5 microns in tangential diameter, with walls 5.7 microns thick; at the periphery, 78 microns in radial diameter, 15.6 microns in tangential diameter, with walls 7.8 microns thick; these chambers arranged in circles.

In vertical section the wall between the equatorial chambers and the lateral chambers 15.6 microns thick. Vertical diameter of the equatorial chambers 20 microns at the center of the test and constant to the periphery. Vertical diameter of the lateral chambers 82 microns near the central part of the test; thickness of the horizontal walls 35 microns. There are 15 lateral chambers on the sides of the equatorial layer near the center of the test.

Occurrence: In a grayish-brown, calcareous, gritty sandstone exposed near Calita Sal, Department of Piura, Peru. Associated with *"Orthophragmina" (Asterodiscocylina) stewarti* W. Berry, *"Orthophragmina" (Discocylina)) peruviana* Cushman and *"Orthophragmina" (Asteriacites) calita* W. Berry.

This species looks very much like *O. Clarki* Cushman and *O. pratti* Michelin but differs in having all the papillae the same size. It differs from *O. peruviana* in being very much thinner in proportion to the diameter. The paper-thinness of the test and the small, raised boss permit it to be easily recognized.

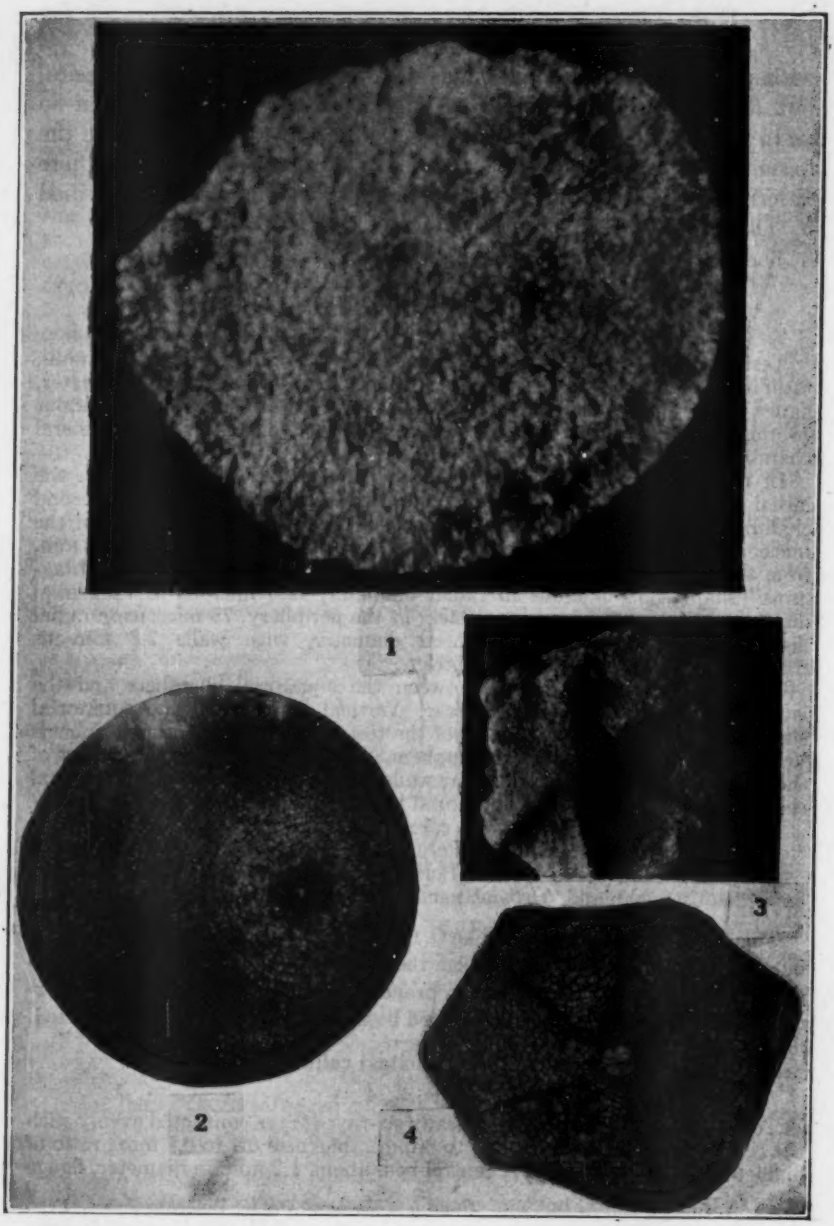
"Orthophragmina" (Asteriacites) calita W. Berry, n. sp.

Figs. 3, 4

Test medium, thin, stellate, typically six-rayed; rays connected evenly with the central boss; diameter from 4 to 6 mm., thickness 0.4 to 0.7 mm., ratio of diameter to thickness 8.6 to 1; central boss about 1.2 mm. in diameter, flange

[4] A. A. Olsson and A. Iddings. *Geology of northwest Peru.* Bull. Am. Assoc. Petr. Geol. **12**. 1928.

[5] A. A. Olsson. *Contributions to the Tertiary paleontology of northern Peru, Pt. I, Eocene Mollusca and Brachiopoda.* Bull. Am. Pal. **14** (52). 1928.



Figs. 1, 2.—*Orthophragmina salensis* W. Berry, n. sp. 1, surface of test ×10; 2, equatorial section ×20.

Figs. 3, 4.—*Orthophragmina calita* W. Berry, n. sp. 1, surface of test ×10; 2, equatorial section ×20.

2.3 mm. in diameter; rays fairly wide (0.4 mm.) and evenly curved or U-shaped; inter-ray areas level. Entire surface slightly reticulate; no evidence of any pillars. Surface diameter of the lateral chambers 78 microns.

In equatorial section; the nucleoconch composed of the initial chamber 109.2 microns in diameter, surrounded for about two thirds of its circumference by the second chamber; diameter of whole nucleoconch 218.4 microns, with walls 11 microns thick. Equatorial chambers normally rectangular, but elongated radially at seven places, giving rise to seven ray like series of chambers. Normal equatorial chambers at the center 31.2 microns in radial diameter, 19.5 microns in tangential diameter, with walls 9 microns thick; at the periphery, 46.8 microns in radial diameter, 19.5 microns in tangential diameter, with walls very thin, only 3 microns thick. Equatorial chambers of the "rays" at the center 46.8 microns in radial diameter, 19.5 microns in tangential diameter, with walls 7.8 microns thick; at the periphery, nearly the same size, 46.8 microns in radial diameter, 21 microns in tangential diameter, with walls 5.6 microns thick.

In vertical section the wall between the equatorial chambers and the lateral chambers 7.8 microns thick. Vertical diameter of the equatorial chambers 19 microns at the center of the test, increasing evenly to 43 microns in diameter at the periphery. Lateral chambers arranged in columns; vertical diameter 19 microns near the surface at the center of the test, the horizontal walls about 5 microns thick. There are a total of 18 lateral chambers on the sides of the equatorial layer near the center of the test.

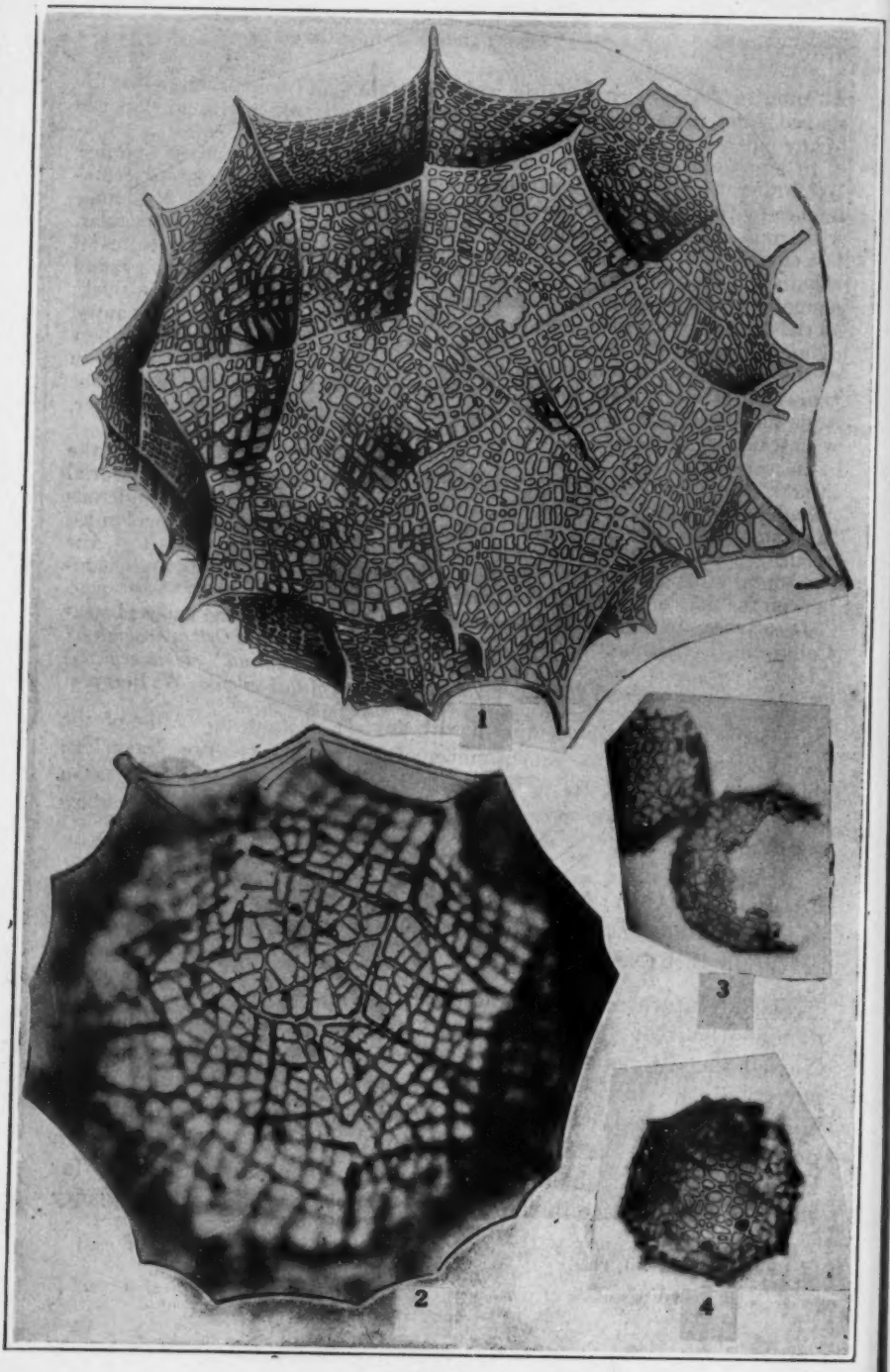
Occurrence: In a grayish-brown, calcareous, gritty sandstone exposed near Calita Sal, Department of Piura, Peru. Associated with *"Orthophragmina"* (*Asterodiscocylina*) *stewarti* W. Berry, *"Orthophragmina"* (*Discocylina*) *peruviana* Cushman and *"Orthophragmina"* (*Discocylina*) *salensis* W. Berry.

This species cannot be compared with any that I know of. Most of the described forms have the same number of interior and exterior "rays." In this species, however, there are constantly six surface "rays" and seven interior "rays." I have no sections of the six-rayed forms that do not show seven interior "rays."

PALEONTOLOGY.—*Two new larger Radiolaria from Peru.*[1] WILLARD BERRY, Johns Hopkins University. (Communicated by JOHN B. REESIDE, JR.)

The literature on fossil Radiolaria is relatively meager and predominantly relates to the smaller flask-shaped or conical forms of Nassellaria (Monopylaria) and Phaeodaria (Tripylaria). The discovery of two large related species belonging to the group which Haeckel christened Order Phaeosphaera is therefore of especial interest, not only because of their size but also because of their presence in large numbers in a shallow water deposit. The illustrations fall far short of doing justice to the exquisite beauty of the fossils, a beauty

[1] Received March 1, 1929.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which may be visualized by comparison with the accompanying copy of Haeckel's drawing of *Oroscena huxleyi*, a very similar existing species.

Members of the Phaeosphaera were first discovered by the Challenger Expedition and in his account of the Radiolaria Haeckel referred to the order 27 species in 4 genera. They are remarkable for their size, averaging from 1 to 3 millimeters in diameter. The tests are relatively coarse, mostly subspherical, and without special apertures. Haeckel speaks of them as rare and confined to great depths (1095 to 3125 fathoms), failing to recognize that the large size and spherical form stamp them as pelagic, surficial types—an indication which seems confirmed by the finding of the present species in abundance in shallow-water sediments. Presumably the material studied by Haeckel came from bottom samples of radiolarian ooze, but it seems remarkable that they have not been taken in tow nets, if indeed they have not, since they occur in all of the warmer oceans.

The present specimens came from a depth of 365 feet in a boring southeast of Bayovar, department of Piura, Peru, where they were associated with fragments of echinoid spines; tiny broken fishbones, vertebrae, and teeth; and numerous smaller foraminifera, including *Cristellaria, Textularia, Miliolina, Uvigerina, Nonionella,* and *Bulimina.*

The age is probably Pleistocene.

The new species may be described as follows:

Oroscena bayovarana W. Berry, n. sp.

Fig. 2

Subspherically polyhedral, averaging 1.5 millimeters in diameter exclusive of the radial spines. Lattice coarse both as to the aerolation and the size of the siliceous mesh. The coarser rods, 2 or 3 times the diameter of the finer rods, form rafter-like, somewhat concave ridges bounding the larger polygonal areas, which are pronouncedly concave. The lattice within the concave areas formed by the larger rods is made up of delicate rods subtending 3 to 5 sided areolae; and many of these rods bear one to several fine spines in the plane of the lattice, frequently extending half way across an areola. Where the larger rafter-like rods join, usually in threes but sometimes in fours, they curve outward like an A tent and form the base for a stout radial spine. In the fossil material these spines are all broken off a short distance above their bases, and it is impossible to determine whether they were simple or branched.

Fig. 1.—*Oroscena huxleyi* Haeckel, ×50, tropical Atlantic
Fig. 2.—*Oroscena bayovarana* W. Berry, n. sp., ×56, Peru
Fig. 3, 4.—*Oroscena peruviana* W. Berry, n. sp., ×30, Peru

This species is less abundant than *Oroscena peruviana*. In its general form it is closest to the existing *Oroscena huxleyi*, described from 2740 fathoms in the Atlantic west of the Canary Islands, but differs in its somewhat smaller size, larger meshes, and greater development of secondary spines.

Oroscena peruviana W. Berry, n. sp.

Figs. 3, 4

Nearly spherical, the average diameter near 1 millimeter. The rods of the lattice show less differentiation, being more nearly uniform in diameter, lacking concave areas bounded by larger rods. The angles of the mesh, and hence the areolae, are rounded. The radial spines are more numerous than in *Oroscena bayovarana* and relatively stouter, but all are broken off so that their distal character is unknown; they are smooth as far as preserved and the framework at their base does not recurve tentlike as in the associated larger species. An additional distinctive feature of *P. peruviana* is the smoothness of the rods of the lattice, no traces of lateral spines having been observed. This species is exceedingly common.

PALEONTOLOGY.—*Coleoptera from the lower Eocene (Wilcox) clays.*[1] H. F. WICKHAM, Iowa City, Iowa. (Communicated by EDWARD W. BERRY.)

Some time ago I received from Professor Edward W. Berry of the Johns Hopkins University, a small lot of coleopterous elytra from the Wilcox clays of lower Eocene time. As no Coleoptera are described from this horizon it has seemed worth while to characterize and name the material, even though it is insufficient to give any definite clues as to the climatic or other local conditions.[2]

Genus ELATER Linnæus

Elater berryi Wickham, n. sp.

Fig. 3

Represented by an elytron, 8.50 millimeters long and 2.75 millimeters wide, the extreme tip lacking. It is of narrow form, the sides sub-parallel for the major part of the length, the tapered portion so much injured that its proportionate size can not be measured. The surface is moderately finely

[1] Received March 1, 1929.

[2] It has always been a subject for comment that the remains of insects were so scarce in the fine grained clays of the Wilcox group which contain such a wealth of delicate plant material. In 1925 Dr. Collins described the wing of a termite (R. E. L. COLLINS. Am. Journ. Sci. 9: 406–410. *fig. 2*, 1925) and in 1927 I described the cases of a caddis worm (EDWARD W. BERRY. Proc. U. S. Natl. Museum, 71, Art. 14. 1927) from these beds. Professor Wickham has now described the few beetle elytra resulting from very intensive collecting during which over 500 species of plants have been obtained. We have a single wing of some hymenopterous form and other caddis cases which have not yet been described. *E. W. B.*

and evenly 8-striate, the striae finely but distinctly and regularly punctate. The interspaces are slightly convex and appear to have been minutely punctulate, but this may be due to the texture of the matrix.

Holotype.—Cat. No. 80474 U. S. Natl. Museum.

The specimen bears the collectors number 35, and was obtained 4 miles north of Jackson, Madison County, Tennessee. I think that there can be no doubt of its being an Elaterid. The generic name is used in the Linnæan sense.

Genus MELOLONTHITES Heer

Melolonthites collinsi Wickham, n. sp.

Fig. 4

Described from an elytron, 14.65 millimeters long by 6.05 millimeters wide, strongly declivous at the apex, with well defined outer marginal bead and two obtuse discal costae, outlined by punctures, similar to those of many recent species of Phyllophaga. The sutural margin is also beaded. Within it are two obtuse approximate costae, more distinct on the posterior half of length, where their limiting striae are finely punctured. The whole elytral surface is finely and diffusely punctate.

Holotype and paratypes.—Cat. No. 80475, 80476 U. S. Natl. Museum.

The holotype is marked with the collectors number 34, and is from the Holcomb Property, Henry County, Tennessee. The paratype shows both obverse and reverse, and is from 4 miles north of Jackson, Madison County, Tennessee. The specific name refers to the collector of the Henry County specimen, Dr. R. E. L. Collins.

I have looked in vain for anything in recent Scarabæidæ which will exactly match the costal arrangement and come back, after each search, to Phyllophaga, which the elytra strongly suggest. Probably the best course is to put it in Heer's genus *Melolonthites*, since there is too little shown to support a new generic name.

Genus OTIORHYNCHITES Heer

Otiorhynchites wilcoxianus Wickham, n. sp.

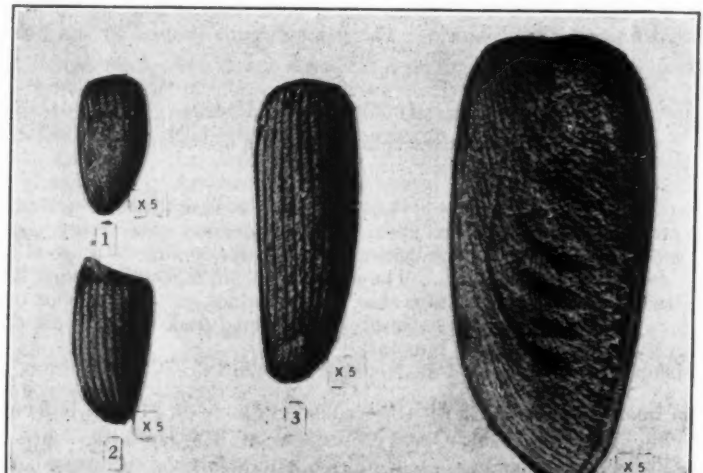
Figs. 1, 2

Based upon an elytron, 4.25 millimeters long by 2.35 millimeters wide, strongly convex, moderately arcuately narrowing to the tip. Surface regularly and rather deeply striate. Striae evenly and coarsely punctate for the entire length. Interspaces convex. The punctures of the external striae appear to be larger than those near the suture and on the discal region. However, the disk has been injured by abrasion so that the sculpture is effaced over a considerable area.

Holotype and paratypes.—Cat. Nos. 80472, 80473, U. S. Natl. Museum.

The holotype carries the collectors number 33, and is from the pits of the Texarkana Pipe Co., Miller County, Arkansas. A second specimen, designated as the paratype, is from the Bradley Pit, Henry County, Tennessee.

This appears to have been an Otiorhynchid weevil of the general form of the recent *Geoderces incomptus* Horn, but may have been even stouter. It is not possible to determine how much of the elytral width is due to flattening out of the original convexity.



Figures 1, 2.—*Otiorhynchites wilcoxianus* Wickham, n. sp., ×5
Figure 3.—*Elater berryi* Wickham, n. sp., ×5
Figure 4.—*Melolonthites collinsi* Wickham, n. sp. ×5

PHILOSOPHICAL SOCIETY

983D MEETING

The 983d meeting was held at the Cosmos Club, January 5, 1929, President ADAMS presiding.

Program: Address of the retiring president, Dr. PAUL R. HEYL: *The lingering dryad.* (This JOURN. **19**: 73–84. 1929.)

984TH MEETING

The 984th meeting was held at the Naval Observatory by invitation of the Superintendent, Capt. C. S. FREEMAN, on January 19, 1929. No formal proceedings were followed, but the members and guests were divided into four parties to inspect the various instruments and the exhibits illustrating the methods of computation and reduction of observations. Through the courteous attention of the guides and attendants, the work of this excellent scientific institution was vividly pictured to those present. All were grateful for such an opportunity on an ideal night.

985TH MEETING

The 985th meeting was held in the Cosmos Club, February 2, 1929, President Adams presiding.

Program: H. G. DORSEY: *The fathometer and apparatus used in radio acoustic ranging.* In any method of measuring ocean depths by sound waves it is necessary to have a sender, a receiver, an indicator, and usually a power plant.

In the type 312 fathometer the sender is called an oscillator. It is secured to the bottom of the ship when in dry dock and sends a compressional wave into the water whenever it is actuated by 525 cycle alternating current generated by a small power plant. The oscillator is about 13 inches in diameter and 4 inches thick. The diaphragm has a natural frequency of 1050 cycles when in water and is vibrated by the pull of each half cycle of the alternating current, doubling the frequency, since there is no polarizing field. The sender produces a sound at the bottom of the ship which goes to the bottom of the ocean and is reflected back as an echo.

The receiver, called a hydrophone, is similar to a telephone transmitter, made waterproof, and is located in a tank filled with water, inside the ship, the bottom of the tank being the ship's hull itself so that only the thin steel plating separates the water inside the tank from the water outside the ship. When the echo makes the diaphragm of the hydrophone vibrate, the motion changes the resistance of the carbon microphone and these resistance changes in an electric circuit produce an alternating current which is amplified to such an extent that it will produce a single instantaneous flash in a neon tube for each echo.

The indicator has the neon tube mounted back of a radial slot on a disc so that when the tube flashes a line of red light is seen through the slot. In front of the disc is mounted a transparent scale, graduated to 100 divisions. The disc is rotated at a constant speed of approximately four revolutions per second. Thus as a time measuring device each division represents one four-hundredth of a second, or 0.0025 second and the width of the divisions and sharpness of the edge of the slot enable one to estimate to a tenth of a division. The velocity of sound in sea water is roughly 4800 feet per second or 800 fathoms. Since the sound has to go through the water twice to produce an echo it goes through a depth of 400 fathoms in one second or one fathom in the time interval represented by one division of the graduated scale. Thus the indication is a direct reading in fathoms.

The shaft which rotates the disc also has a cam which closes, for a short interval during each revolution, the electric circuit from the power plant to the oscillator producing a short musical note in the water as the neon tube passes the zero of the scale. While the sound is going down and coming back the neon tube is rotating at a uniform rate and when the echo is received the exact instant is marked by the red flash. Since the disc is dark all the time except for the flash, depths are read as easily as telling time by a clock. If the depth is more than 100 fathoms it is only necessary to add a hundred for each revolution.

This method is used until depths are so great that the amplified echo can not operate the neon tube and then a change of gears and of the method are made so that a slowly rotating steady white line is watched and its position on a scale is noted when the echo is heard in a telephone receiver. By this method depths as great as 3000 fathoms have been measured.

Ten of the Coast and Geodetic Survey ships are now equipped with fathometers which greatly increase the speed of measuring depths. Besides measuring the depth, however, it is also necessary to know the ship's position if the depth measurement is to be of any value. This is usually determined by taking sextant angles of three shore signals, but the following method is also used.

The radio acoustic ranging method of locating a ship's position consists in firing a small bomb in the water by the ship and receiving the sound in hydrophones by two shore stations. The time of the explosion is recorded on a chronograph tape at the ship, on which are also recorded time intervals of seconds from a chronometer. Then when the sound of the bomb is received by the two hydrophones at widely separated shore stations a radio signal is automatically sent back to the ship by each station and recorded on the tape with the time and bomb records. The tape is moved at a uniform rate of about 2 centimeters per second by a battery-operated motor and the time intervals are readily measured to hundredths of a second.

The positions of the shore stations are accurately located by surveying and may be from 20 to 40 miles apart. Knowing the velocity of sound in water the three sides of the triangle become known and the triangle is soluble. By this method the ship's position may be determined even as far as 200 miles from shore and the great advantage is that the operation may be done in foggy weather or at night time when the shore is entirely invisible either due to lack of light or because of the earth's curvature.

It might be mentioned that radio acoustic position finding was started as a further development of World War work, aided by the United States Bureau of Standards and the United States Coast Artillery, as described in Coast and Geodetic Survey Special Publications No. 107 and 146.

The features of measuring the short time intervals involved in the fathometer were first described in the Journal of the Optical Society of America and Review of Scientific Instruments for September, 1924 and the instrument was patented by the author April 24, 1928. (*Author's abstract.*)

W. E. PARKER: *Echo-sounding and sound-ranging in hydrographic surveying and navigation.*

OSCAR S. ADAMS, *Recording Secretary.*

ENTOMOLOGICAL SOCIETY

407TH MEETING

The 407th regular meeting was held at 8 P.M. Thursday, January 3, 1929, in the National Museum. President J. E. GRAF presided. There were present 24 members and 16 visitors. The regular annual report of the Recording Secretary was read and approved and that of the Corresponding-Secretary-Treasurer was read and referred for audit.

Professor GEORGE A. DEAN, Kansas State Agricultural College, Manhattan, Kansas, conveyed greetings to our organization from the Kansas Entomological Society. He gave some data on the organization of the Society and the present interest in and demand for its recently established Journal. He also gave a résumé of the history of entomology at Kansas Agricultural College, its beginning in 1867 under the leadership of the late Professor B. F. Mudge and its continuance under Professor Riley, Professor Whitman, Professor Popenoe, Dr. Headlee, and others. A review also was given of the

entomological work at the State University from that of Dr. Snow in 1867 down to date. Some facts pertaining to the status of Kansas entomology were presented: Exclusive of student helpers, there are 24 active entomological workers in the various Kansas educational institutions and government research laboratories, while fully 100 Kansas men in various parts of the country are or have been actively identified with entomological work, including Williston, Kellogg, Marlatt, Knaus, Gahan, Aldrich, and Parrott. The U. S. Bureau now employs 16 Kansas State College men, 15 of whom were formerly Professor Dean's students. These remarks were commented on by GRAF and HOWARD.

Dr. WALTER CARTER, of the Bureau of Entomology Laboratory at Twin Falls, Idaho, also greeted the Society and gave a brief summary of work in the Northwest on the sugar beet leaf hopper and associated insects. He reviewed some of the methods in use, and analyzed some of the more important general factors bearing on the control of insects. These remarks were discussed by BAKER.

Dr. H. L. DOZIER, Agricultural Experiment Station, Newark, Delaware, gave a brief review of the history of entomological work in Delaware for some years past, from the work of Prof. Sampson in 1902 and of Prof. Holton in 1905 down to the present time, describing present entomological work in the State and his own laboratory and equipment. Comment on Dr. Dozier's remarks was made by HOWARD.

Dr. C. H. BATCHELDER, of the European Corn Borer Laboratory at Arlington, Mass., gave some of his impressions, more or less humorous in character, of the Society meeting and of the present entomological situation as a whole in this country.

Mr. A. W. CRESSMAN, of the Bureau of Entomology's Tropical and Subtropical Insect Laboratory at New Orleans, Louisiana, referred briefly to some of the problems in connection with his work on Rodolia Beetle and the camphor scale. The U. S. Bureau of Chemistry and the Bureau's Florida Laboratory are cooperating in an extensive program of investigations dealing with the physical characteristics of oils, emulsifications, etc.; and the perfecting of technique on the biological side of the problems, especially control of camphor scale and other scale insects by use of oils and oil emulsions and by fumigation. These remarks were discussed by HOWARD and MORRISON.

Dr. F. M. WADLEY, of the Insect Pest Survey of the Bureau of Entomology, expressed his satisfaction at being able, because of his recent transfer to Washington, to attend regularly the future meetings of our organization.

Mr. O. E. GAHM, of the Branch of Truck Crop Insect Investigations of the Bureau, spoke briefly of his recent transfer to Washington and of his present work at Arlington Farm on mushroom insects.

Mr. EUGENE D. EATON, of the Bureau of Entomology Laboratory at Carlisle, Pennsylvania, referred feelingly to some of the perplexities experienced by the beginner or near-beginner in entomology. He enumerated some of the difficulties encountered recently in connection with his work on Hessian fly and its parasites, especially those pertaining to such factors as climate and environment. Comments were made by GRAF and BAKER.

Regular program: Dr. N. E. MCINDOO, of the Bureau of Entomology: *Tropisms and sense organs of Lepidoptera.* This paper was divided into two main divisions: Tropisms and Tropic Receptors. It was pointed out that zoologists and entomologists should say phototaxis, chemotaxis, geotaxis, etc., instead of saying phototropism, chemotropism, geotropism, etc. Under

phototaxis the following headings were mentioned: (*a*) Definitions and problems in study of light reactions; (*b*) are light reactions adaptive?; (*c*) is orientation accomplished by selection of trial movements?; (*d*) how do light rays bring about orientation?; (*e*) do circus movements support Loeb's theory?; (*f*) what wave lengths stimulate insects most?; (*g*) light traps are not yet considered successful; and (*h*) phototactic experiments on codling-moth larvae.

Chemotaxis, geotaxis, and thigmotaxis were also briefly referred to. Instead of saying that an insect is positively phototactic, negatively geotactic, positively chemotactic, and positively thigmotactic, it is better to say photopositive, geonegative, chemopositive, and thigmopositive.

The tropic receptors include photoreceptors, chemoreceptors, audireceptors, thigmoreceptors, georeceptors, and other receptors. Most of these were illustrated with lantern slides.

In Lepidoptera there are three types of so-called olfactory organs on the antennae: end pegs, pegs, and pit-pegs. Since no one has ever found nerves running to the end pegs, they should no longer be regarded as sense organs. If the pegs and pit-pegs are the only olfactory receptors in Lepidoptera, then 12 of the 34 individuals examined cannot smell, because these particular sense organs are totally absent. The organs called olfactory pores by McIndoo have been found on all adult and larval Lepidoptera yet examined.

The so-called taste organs are peculiarly shaped hairs situated on the distal half of the proboscis. Minnich's tarsal chemoreceptors in butterflies are also regarded as taste organs. This writer has shown that these organs, when properly stimulated, are 256 times as sensitive as are the taste organs in the human mouth.

Under audireceptors the following so-called auditory organs were briefly discussed: tympanic organs, chordotonal organs, Johnston organs, and auditory hairs. This talk was concluded by a brief discussion of tactile organs, balancing organs, and scent-producing organs. (*Author's abstract.*)

Owing to lateness of the hour discussion of Dr. McIndoo's paper was postponed until the next meeting of the Society.

J. S. WADE, *Recording Secretary.*

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